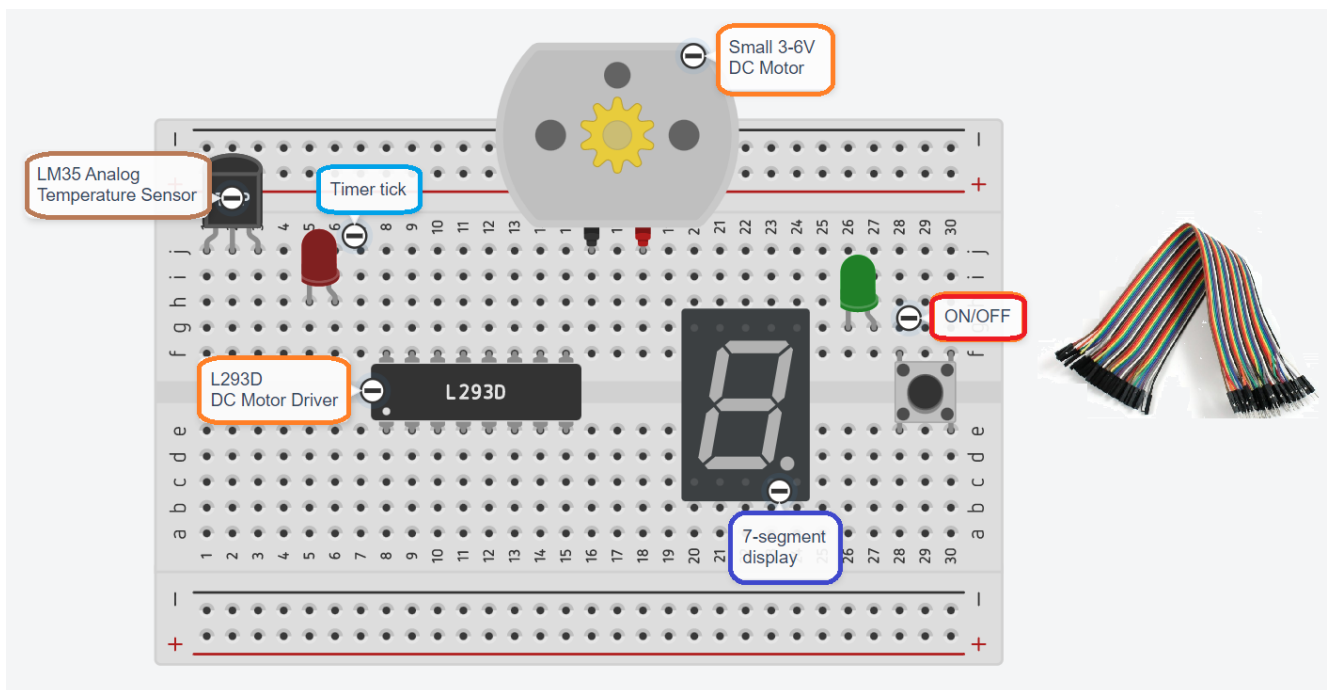


# Assignment #4: DC Motor PWM Driving with Temperature Level Control

Marmara Uni. EEE Dept. CSE 2037 System Programming

Due date: January 8, 2023 23:59

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device is rated to operate over a  $-55^{\circ}\text{C}$  to  $150^{\circ}\text{C}$  temperature range. A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. In order to drive a DC motor, we also require a driver IC named L293D. You have to arrange the inputs and outputs (I/O) in an STM32 micro-controller. (You can use either your own STM32 MCUs or STM32F407VG Discovery in our Lab.)



## Operation Sequence:

1. All the LEDs and the 7-segment display must be turned off initially.
2. When the push button is pressed, the green LED is turned on and 7-segment displays the initial temperature level in accordance with the Table 1. In order to terminate the system, the push button should be pressed once again. In other words, MCU always waits for the ON/OFF button to be pressed to process. **Hint 1:** The Interrupt concept should be used.
3. You should use a timer to obtain the analog output from the LM35 Temperature sensor. Specifically, temperature value must be updated once at each 250 ms. **Hint 2:** The timer and ADC should be used.

Temp. Level	7-segment display	Temperature Ranges
Level 1	0	0.0 °C - 10.0 °C
Level 2	1	10.1 °C - 20.0 °C
Level 3	2	20.1 °C - 30.0 °C
Level 4	3	30.1 °C - 40.0 °C
Level 5	4	40.1 °C - 50.0 °C
Level 6	5	50.1 °C - 60.0 °C
Level 7	6	60.1 °C - 70.0 °C
Level 8	7	70.1 °C - 80.0 °C
Level 9	8	80.1 °C - 90.0 °C
Level 10	9	90.1 °C - 100.0 °C

Table 1: Temperature Level Displays

4. Timer tick Red LED must blink for (10 ms) at each tick of the timer, i.e., once in 250 ms. **Hint 3:** The timer concept should be used.
5. 7-segment displays a number in line with the provided temp. ranges in Table 1. Note that there are 10 temp. levels for the temperature display.
6. The DC Motor must be driven by PWM in accordance with the temp. levels provided in Table 1. Lower the temperature level means slower the Motor revolution. Likewise, highest the temperature level means faster the Motor revolution. **Hint 4:** The PWM concept should be used.

**Be careful about:**

- the **Hints**. All of them should be considered to obtain full credit,
- the LEDs and the push button. You may be needed to add pull-up or pull-down resistors,
- the jumper types. They should be male-to-female jumpers as given in the figure if you are going to use the STM32 Discovery Board in our Lab.

**Ground Rules:**

1. You will program the STM32 MCUs in C language. You should install STM32Cube IDE and ST-Link Utility (driver) in your computers.
2.  $2 \leq \text{number of team members} \leq 5$ .
3. Write a report that includes following chapters:

**Ch. 1:** Explain your algorithm briefly and provide a flow chart that illustrates your algorithm. (You can find a flow chart example in [here](#).)

**Ch. 2:** Copy and paste only the codes you have developed in C. Do NOT copy the auto-generated comment parts in the code. (Screenshots for the codes will be punished.)

**Ch. 3:** Image of your circuit board while running must be provided. (For example, take a photo while green LED is turned on and 7-segment displays a temperature level. (The room temperature can be considered.))

4. Each team should prepare a single report. (You should include all the team members in the document.)
5. Your report should not exceed the total pages of 4. No need for cover page, just write all the team members and the assignment number at the top of the first page as we did in this assignment doc.
6. No hard copy needed. Send your reports in **.pdf** format to the mail address of [ee.cse2037@gmail.com](mailto:ee.cse2037@gmail.com). We will only consider the submissions to this mail address !!!
7. Only 1 (one) student should send the project report and s/he must add all team members to the CC of the mail !!!
8. We will also do a demo in an appropriate time. We will announce the schedule later.
9. Late submissions will not be considered! (Even 1 min.)